Sustainability, Innovation, and Competitiveness in Tourist Clusters: An Empirical Model of Caribbean Destinations.

Sam Cole, University at Buffalo.

Chapter for Ö. Öner et al, Regional Science Perspectives in Tourism and Hospitality. Springer, 2019

Summary

This chapter explains a model of a small island tourism cluster in a highly competitive global economy. The parameters of the model describe the accessibility and intrinsic attraction of destinations, the synergy among accommodation and other tourism activities within destinations, the increasing congestion as each destination reaches its notional capacity, and the competition-driven, region-wide synergy-enhancing, congestion-offsetting technical changes. The model engages parameters at four physical scales, global markets for capital and visitors, regional destinations and innovations, destination-level clustering of accommodation and tourist activities, and their characteristic production units. Parameters are estimated using data for 1987-1996 for 20 destinations across the Caribbean. These estimates of aggregate technology and change have been applied to an island-specific model to track arrivals and accommodation trends against known data including public subsidies and other tourism policies. The model plausibly backcasts the observed early development prior to the mid-80s, and forecasts the rapid growth and overshoot resulting from excessive subsidies in the late-80s, followed by a decade of disruptive fluctuations. Although, projected to the present time, the model over-estimates the recorded hotel accommodation, the excess matches well the emergent and currently uncontrolled growth of “alternative” accommodation, primarily condominiums and vacation rentals. These empirical examples illustrate how the model components and parameters impact critical junctures in the growth trajectory of destinations.

Keywords: Tourism Clusters, innovation, temporal variability, sustainable destination development.

Introduction

This chapter addresses theoretical and empirical challenges posed by the growing literature on tourism innovation and ongoing changes in the tourism industry. The primary goal here is to explore how behaviors observed in destination tourism arise from their configuration as clusters of activity within the global industry The focus then is how the tourism system itself through structure, behavior, and innovation, rather than a multitude of components, might generate complex behavior, and how this is impacted by present tourism trends.

Our analysis is centers on small Caribbean destinations, partly because of familiarity, but more so that islands provide useful empirical case studies that compound issues of physical scale, heritage, sovereignty, and sustainability. As Carlsen and Butler (2011) observe, ''islands form perfect 'living laboratories' that enable researchers to isolate the causal and immediate effects of tourism development on the community, environment, and economy of islands and to study them at a level of detail that is not possible in other tourism destinations.''

The theoretical model used here is an extension of Butler's (1980) destination life cycle (now TALC). This model describes how destinations could pass through successive stages of exploration, involvement, development, consolidation, stagnation, to decline. Across the tourism literature, the TALC is discussed as both an innovation- and market-led phenomenon, informing tourism authorities on their role in financing, marketing, and leadership. Hjalager (2006) adds a global dimension to the TALC. She proposes that the globalization of tourism proceeds through four stages in a logical advance from simple forms to more complex ones - Missionary, Integration, Fragmentation, and Transcending. The model in this paper too steps beyond the TALC to formalize how the different physical scales of tourism - global, regional, destination, and enterprise levels, together with their characteristic styles of tourism and related industry policy impact a destination's growth trajectory. Each level is conceived as a cluster with aggregate properties, recognizing that, in small destinations especially, the properties overlap.

Empirically, the approach used here is an extension of Cole (2009, 2012a) combining time series data for Caribbean island destinations to estimate key parameters of a destination's attractiveness to markets, accounting for regional and local clustering, property-size, and associated innovation. This estimation, together with recorded exogenous shocks and island policy, is matched against the historic trajectory of a single destination, Aruba. The results suggest that, despite variations of content and packaging of destinations, vacationers and investors across markets and within destinations share core expectations and trade-offs. One current policy concern is the rapid expansion of the "alternative" accommodation – mainly private rentals, small hotels, as opposed to chain hotels and resorts. marketed through social media: AirBnB, HomeAway, TripAdvisor. Estimations of alternative accommodation in Aruba are compared to the predictions of the estimated model.

Caribbean Tourism

Their complex histories have endowed Caribbean islands with distinctive cultures and environments that provide the basis of their tourism products and markets – beyond the sun, sand, and sea of their tropical location. Spurred by rising incomes and passenger jet aircraft after WWII, tourism has become a major driver of economic growth, employment, and government revenues - accounting for from 8 to 40 percent of GDP (IMF, 2014). Across the Caribbean, a dozen islands draw over 50 percent of visitors travelling from East Coast North America, (for example, Aruba, The Bahamas, Bermuda, Virgin Islands). Beyond, the issue of accessibility, Historical connections with a former colonial power, including a shared language are similarly important. While, the flavor of Caribbean destinations rests on their distinctive island cultures, and tourism is their principal export, few islands have many residents prosperous enough to share tourist amenities.

The Caribbean spans 2.5 million square kilometers across distances of 2.5 thousand km. Flight-times range from 1hr for visitors from coastal South America and 12 hours for Europeans. Between islands, travel is often indirect via mainland airports. For the major markets in the Eastern United States, the minimum flight-time is from 3 or 5 hours, but with local travel, check-ins and security, consumes a full day. That said, the availability of direct flights, speedy border arrangements, and trouble-free local travel, are highly important to visitors to the Caribbean (Cole and Razak, 2012). Larger islands, Jamaica and Puerto Rica, have several tourist centers, and even multiple airports, while in others, such as the USVI and the Bahamas, include several islands. The numbers of arrivals in all islands are impacted by swings in visitors' home economies and seasonal weather. Several have suffered major temporary declines due to hurricanes, crime, and social troubles.

The islands attract visitors from other Caribbean islands and South America. In total (as of 2016), markets in North America, Europe, and the Caribbean Basin supply 52, 25, and 23 percent of visitors respectively. Today, the region's share of the global market is shrinking (WTTC, 2018), placing additional pressures on tourism enterprises and authorities. Several islands attract the majority of visitors from their former European rulers: notably some 80% of arrivals to Guadeloupe are from France. In contrast, political stances ensure that few Americans visit Cuba directly, despite her proximity. The type of hotel adopted across the islands reflects the tourist market and their social and economic conditions. Accommodations range from large casino resorts with several thousand rooms, through all levels of chain-hotels and timeshare with several hundred rooms, to specialized boutique properties, and traditional pension and private rentals. As an over-generalization, Islands favored by North Americans tend to be larger (in terms of the number rooms and facilities), while Europeans favor smaller properties, with comparable variation across age, family, or income.

Despite their marked differences, Caribbean destinations, nonetheless, are part of a regional Caribbean-wide market, in turn, part of a global industry. International hotel chains operate globally and regionally. They share marketing, technologies, innovation, and investors, reflecting visitors' expectations and expenditures on amenities a adapted to local markets. etc. as well a corporate need to achieve scale economies and extend their brands. With considerable temporary and permeant migration between islands and beyond, there is importation of activities, cuisines, entertainment, and traditions. Thus, as a first approximation, it may be assumed that, on the

supply-side, underlying incentives for investment and innovations are shared. Similarly, on the demand-side, despite differences in preferences, visitors share a desire for a satisficing variety.

Aruba

The island of Aruba is used for case study described below, selected for reasons of familiarity with the Island's history and availability of data (Cole and Razak, 2009, 2012) illustrates how specific local public and private initiatives, and overseas disturbances have affected the trajectory.

Tourism in Aruba, like several other Caribbean destinations evolved during the 1960s and 70s from a few small hotels and occasional cruise ships. And, as with many other destinations, the decision to initiate, develop, or expand tourism was propelled by an economic crisis: in this case to offset laid-off workers from island's global-scale American-owned oil refinery. The initial development involved American style chain hotels, subsidized by the government and by airlines seeking to expand. Tourism evolved as adjacent clusters, "low" and "high" rise, appealing to European and North American visitor respectively. With a record of safety, fulfilled expectations, and political stability (protected within the Kingdom of the Netherlands) the island remains a favored destination. But, as Figure 1 shows, the number of arrivals to Aruba from US states, Canada, the Netherlands, and neighboring nations and islands according to airport-to-airport flight-time. While this time-distance explains some of the variation, other factors: availability of direct flights (shown as triangles) and local tourist offices (shown as large circles) are relevant. Moreover, there is a chicken-and-egg relationship between marketing, access, and arrivals. The chart shows also the number of visitors as a percentage of their home market population. While there is a clear distance decay as with other gravity-style models, there are clearly many other factors are involved, not least home-to-departure airport travel, political contingencies, or special activities. For nearby Venezuela, without direct flights to and from the United States, many "arrivals" are transiting via Aruba. Arrivals from more distant Nevada are primarily "junkets" to Aruba's casinos. As with other US-directed destinations, changed customs and border arrangements significantly determine both existing and new markets (Cole and Razak, 2015).

Figure 1. Aruba Markets and Arrivals versus Flight Time.

As a favored destination, approximately half of travelers to Aruba return at least once in their lives, with some returning annually. Given this, there remains considerable pressure for new development. As a relatively prosperous community, some residents make use of as well, as operate tourist facilities. Nonetheless, the development path has been fraught. Not least, the "final" shut-down of the refinery in the mid-80s promoted an over-subsidized threefold increase. This was followed by a series of stop-go policies towards new hotel construction, side-stepped by condominium and novel developments. These events have added to residents' recurring concerns about sustainability, immigration, and lost revenues.

Today, as a reflection of shifting income distribution worldwide, in several islands, including Aruba, wealthier visitors and residents are increasingly purchasing condominiums, villas, fractional ownerships and timeshares, for personal use and rental income. The expansion of this

(so-called alternative accommodation is largely facilitated by internet marketing. In response, corporations are adopting flexible room use and ownership, meal-plans, and the like, impacts the endogenous structure of a destination. The implications of this are considered later.

Clusters within Clusters

Structurally, the model employed below treats a destination as a "product" comprising a cluster of activities, in turn part of the Caribbean cluster, and so on. As a component of global tourism, "the Caribbean" is conceptualized as a regional cluster sharing location, warm climate, and attractions.

To the degree possible, the model separates exogenous and endogenous motivating perceptions and satisfactions: accessing the destination versus accessing activities within the destination. Within a destination cluster, a visitor will be less satisfied if the tourist activities favored by them are too spatially distributed or inconvenient to access. This inevitably means that the physical design of a tourism cluster should be selective: formally or informally tourism managers, accommodations, and other businesses and attractions should be coordinated. In what follows, individual islands are approximated as single tourism clusters. That patrons use equivalent amenities closest to home or their current location is a central tenet of location theory. With tourism, the clustering of activities around accommodations, or that visitors make use of activities close to the accommodation are widely observed (Shoval, et al. 2011). Others have observed that other attributes, such as "cultural distance" have impacts similar to travel distance (e.g. Patuelli et al, 2014, McKercher, 2018). At best, physical distance (or travel-time) from markets is a first approximation to access, just as the density of activities (such as rooms per km^2 or per km of beach front) must be supplemented by other attributes. That said, the choice of metric to measure non-spatial attributes is conditioned by the available data.

A single mid-sized hotel cannot generate sufficient custom sufficient for visitors' requisite variety in other visitor needs, for, say, a week of family vacation. The clustering of hotels enables this. Equally, many hotels serving differentiated markets clustered with multiple diverse attractions become cluttered and less accessible, so destinations have to be selective. With this, an innovation becomes the evolution of distinctive destination cluster, including the planned introduction of new styles *across* a destination. This may incorporate business-specific adaptations and innovations, such as adding sea-facing rooms, constructing artificial beach, healthy menus, better marketing and informational materials, have implications for the overall spatial perceptions within a destination, just as airport facilities affect the net experience of travel. Adopting a given technology through design, market forces, or otherwise, a destination is positioned to serve selected markets (for example, East Coast American families, well-heeled Europeans). A well-positioned destination offers a clear narrative and sufficiency in its components – accommodation, dining, entertainment, activities, and so on have strong reinforcing synergies aesthetically and spatially, for the duration of each visit, and provide an enticement to return. The model and empirical analysis centers on this notion.

The prevailing technology within a destination cluster is characterized by the style of hotel adopted, boutique, all inclusive, timeshare, resort. Its size is approximated by the number of hotel rooms. Hotels have longevity, compared to most other tourism enterprises, typically a decade between refurbishing, bankruptcies, changes in ownership. Moreover, data are available for most destinations. When clusters comprise few relatively components, discrete changes at a micro-level impact the macro-level, and vice versa. In this sense changes become "lumpy" or "quantized", at least during its initial and later transient development. For example, a additional property impacts occupancy and profitability destination-wide; a new destination in the region shift visitor options, and so on, exacerbated by time delays in planning and development, policy mis-steps, and seasonal climate and socio-political changes. The model helps clarify when and how such interactions might impact trajectories and so identify critical points in a destination's development.

A Global-Destination Framework

Destinations and aspiring destinations encourage tourism for many reasons but, in terms of innovation, the primary challenge is to ensure that the destination achieves and/or maintains a durable Competitiveness, addressed through the twin challenges of Positioning and Sustainability. Upstream and downstream of these three concerns are core community objectives such as employment and revenues, and constraints such as the preservation of environment and heritage. Beyond this is a complex of contending commercial, political, and social agendas.

The conceptual framework for the model shown in Figure 2 comprises several elements within and between the global and destination economies. The global economy (labeled 1) is driven by rising discretionary incomes and wealth and worldwide sources markets, finance, for the tourism sector, and also labor. This sets certain conditions on destinations, in general, for attractiveness to tourists and investors (2), that, if met by any given destination will ensure a sufficient supply of investors and visitors. This in turn sets off a process of agglomeration, first with economies, and subsequently diseconomies of scale (3). This agglomeration process has several interacting elements: reinforcing demand from both visitors and local residents, benefits in terms of cost and variety to accommodation and other tourism-related activities, that together accelerate a destination towards its "carrying capacity" when a destination becomes congested or over-crowded. Congestion arises from expanding tourism both directly (through overcrowded beaches or loss or authenticity) and indirectly via employment (4) including through land-use multiplier (5) effects (from immigration of and downstream tourism and domestic activities).

Figure 2 The Global-Local Destination Model.

The core assumptions about economic globalization in the model are the sufficiency and mobility of capital, labor, information, uncertainty, and demand. The notion of *sufficient* capital asserts that, provided an investment prospect meets international investor expectations capital will become available. Nonetheless, the volatility and fickleness of tourism demand ensures that

investors in the industry seek above average profitability, setting the investment hurdle or discount rate.

Although tourism demand is sourced worldwide, the activity itself is concentrated in specific locations - accessible clusters of accommodation, shopping, dining, entertainment, nature, and other activities. At this scale, as the destination grows, the dominant phenomena are synergistic agglomeration and saturation. The former arises through the clustering of supply and demand-side activities to enhance the attractiveness of products at a location to investors and market segments, the latter arises as the direct and indirect impacts of this localized activity approach some limitation or carrying capacity.

At the scale of production (and especially accommodation), the key characteristics are the incremental character of development: primarily from the lumpiness of new accommodation and the delays in implementation. Overall, with a high growth potential, increasing economies of scale (through agglomeration), plus decreasing economies (with saturation), plus discrete time-steps (decision-making and implementation) destination tourism has all the ingredients of a chaotic system. The next section shows that the general phenomena of globalization, agglomeration, and discreteness can formalized as a discrete logistic equation. While the proposed form is similar to the familiar Lorentz equation, and the Butler TALC (Tourist Area Life Cycle) model, it has several distinctive features.

Tourism Life-Cycle Models

The starting point for the model presented here is the tourism area life cycle model (TALC) originally due to Butler (1980). This remains the most enduring heuristic for understanding the evolution of tourist destinations (Pearce 1989, 2001; Butler 2006). The model argued for the existence of an S-shaped lifecycle in the growth of a tourist destination with identifiable stages—exploration, involvement, development, consolidation, maturity and stagnation—often followed by decline or rejuvenation. Numerous chapters have analyzed and elaborated the assumptions, generality, and practicality of the model.

While the overall S-shaped trend and the idea of stages of development is widely-accepted, there remains a great deal left unexplained by the TALC, not least the tremendous variability in arrivals, occupancy, and accommodation, the irregular patterns of growth and decline, and the succession of products and resorts, or dramatic reactions to relatively insignificant events (see, e.g. Lundtorp and Wanhill, 2001). Butler (2009) too has concluded that a simple model like the TALC and its variants cannot predict in detail the future of a specific destination especially those engaged in the global competition that is tourism today.

The TALC equation is formally identical to the Lorentz chaos model (1963) but does not exhibit the variability associated with tourism primarily because, empirically, the growth potential (as opposed to the growth rate) does not reach the required level. Indeed, it is generally considered that the growth potential) of human population systems (cities, nations) is well below that

required to generate chaos. (Batty, 2005). Nonetheless as this author has shown elsewhere that including an additional term in the Lorentz equation to account for the synergistic effect of clustering boosts the growth potential to a level required to generate highly variable, if not chaotic, trajectories in tourism and other metropolitan areas (Cole, 2009, 2012a). This variability is deterministic, in that it arises from endogenous aspects of the tourism system such as tendencies to over-investment and may be moderated by countervailing policy (Cole, 2012b). This behavior contrasts with the volatility due to irregular "random", singular and concatenated exogenous shocks, (such as those from natural disasters, uneven tourist markets, and so on (Cole, 2018).

Three specific modifications from the TALC are: first, formally, the TALC equation implies that the attractiveness *always* declines as the number of visitors increases, so the attractiveness of a destination declines from day one. Adopting an amenity-based metric (hotel rooms) shifts the emphasis from crowding to visitor satisfaction. Introducing clustered enterprises with synergistic as well as congestion revises this. Second, the TALC uses a continuous (differentiable) equation for the number of visitors. This does not account for the discrete room-size of accommodations. This "lumpiness" provides a less volatile metric for modelling than visitor arrivals with substantive impacts on model trajectories. Third, tourism policy, notably subsidies and moratoria, are introduced explicitly. Whilst several of these issues are discussed in the literature cited above, the modifications, arguably make the model more plausible theoretically and help us to untangle the available data.

Aggregate Tourism Innovation

The tourism innovation and systems of innovation literatures deal primarily with tourism in a national or large region context. Given the high level of globalization of the tourism industry, and especially for smaller destinations, a globalized innovation system is more appropriate. In this chapter, the notion of a global tourism innovation "cloud" is adopted to explain the empirical findings. Within this, each destination's distinctive attributes, arising from its own unique history of innovation and socialization, condition its relative competitiveness and positioning to attract designated markets (for example, East Coast millennials) though style of hotels, entertainment, dining, and shopping. These factors play into the differences in goals between different segments of the tourist market, local and international tourism industry, and the public and populations of destinations. Physical distance, in terms of travel to and within destinations, via perceptions of inconvenience or crowding, is implicit in the variables used.

Carlsen and Butler (2011) observe that there is "no agreed definition or categorization system for innovation in (sustainable) tourism", or "consensus on the underlying factors that drive innovation" Several authors (Buhalis, 2000; and Murphy et al. 2000; Plaza, et al, 2011) explain that the tourism sector encompasses "a myriad of non-technological innovations" embodied in "complex and integrated portfolio of services" should be viewed as "an overall appealing product distinctive to a place". Miles (2016) emphasizes that social sector innovation, in general, involves

a wide range of heterogeneous products and processes with innovations, like other inputs to production, extensively sourced. Hall and Williams (2008) illustrate this for the innovations embedded in regional tourism clusters, as do Weidenfeld et al (2010). Decelle (2004) emphasized the "context of complexity" and that tourism products are composite goods. The boundaries of tourism innovation systems are diffuse because, as Hjalager (2010) explains, tourism and associated innovations are increasingly global in nature, crossing many nations, cultures, and destinations, and that tourism innovations may be readily transferred, overwhelming local cultures and traditions. Nonetheless, Hjalager (2012) especially has argued the need to understand better the ''aggregate innovativeness" of tourist destinations and its implications for "cumulative growth".

Contributions to understanding tourism innovation (e.g. Poon, 1988; Hjalager, 1997; Hall and Williams, 2009) draw together some key concepts from the classic innovation and tourism innovation literatures: product, process, organizational, and so on (Utterback and Abernathy, 1975), noting that these concepts are diffuse. Studies of industrial and creative clusters (e.g. Porter 1990), innovation and trade (e.g. Vernon, 1966 Krugman,1991), systems of innovation (Freeman and Soete, 1987). Ozturk (2009) stresses the importance of networks between the global and local levels. This implies that aggregate innovation must account for the combined contributions of all innovation: large and small, local and imported, public and private, successful or otherwise. Moreover, each of these components itself is a composite of other innovations, each with its own origins and life cycle history. Clarifying this requires us to consider the relationship between the components of aggregate innovation.

In her comprehensive review, Hjalager (2006) explained that innovation research in tourism, as a young phenomenon, was only slowly being elaborated in theory and empirical evidence. She observed that tourism innovation has mainly been examined in a piecemeal case-by-case manner. She showed, however, that tourism research had increasingly begun to address the wider implications of tourism's structures for ''aggregate'' innovativeness and cumulative growth (see also, Nordin, 2003; Mattsson et al., 2005; Guia et al., 2006; Hjalager et al., 2008). Hjalager (2010) argued for "the construction of new empirically grounded theories that account for the distinctive features of tourism" and suggested that "a mix of conventional and tourism specific approaches might improve both. This has become increasingly challenging because, as Nedergaard and Gyrd-Jones (2013) observe, "markets (have) become ever more chaotic through the processes of globalization, technological evolution, increased competition, and rapidly changing consumer needs and wants." Understanding the combined impacts of individual initiatives that confront local and global changes is especially necessary for small island destinations with fragile economies and ecologies.

Certainly, tourism development cannot be treated as "by definition endogenous and fundamentally dependent on the organization of the territory itself" as Capello and Nijkamp (2011) assert, but rather is a complex combination of localizing and globalizing processes. Cesar and Montfort-Mir (2012) too consider that it is necessary to develop a consolidated theoretical framework. Hall and Williams (2009) and Hall (2009) conclude that while there is an obvious quest for better empirical evidence about innovation in tourism, [and that] quantification is essential.

Articulating and estimating an empirical model must confront the limitations of available statistics with incomplete time-series complicated by changing metrics and definitions. Metrics for accommodation have shifted over time from beds, to rooms, to suites, indicating innovation in quality, alongside volume. Given these constraints, our approach is less detailed, than other proposed cluster models. Kim and Wicks (2010, for example, propose a "global competitiveness of tourism cluster development" approach with the tourism cluster as "an organic system with symbiotic relationships." The clustering may be geographic, political, cultural, physical, or more commonly a mixture of several, and arguably as much perceptual as existential.

Most studies of tourism innovation deal with creativity within individual enterprises – hotels, entertainment, tours, etc., rather than a destination or the tourism system as a whole. Pratt and Jeffcutt (2010) suggest that tourism managers maintain competitiveness through innovation in products and services as well as more traditional cost saving via cheaper labor or technological substitution. Nonetheless, the highly dynamic nature of tourism destinations with newer destinations with new businesses better able to employ the latest advances and ease of duplication of services across destinations resulted in a lack of innovation and high failure rates of tourism enterprises in established destinations (Getz, 2004; Carlsen et al, 2008). Any modelling must be informed by such case studies and theories. While the modelling options include, in principle, a variety of agent-based models, demonstrating the dynamics of clustering estimated via the (allegedly) "most accurate and comprehensive" data for metropolitan areas, these are not yet available for the Caribbean (Li et al, 2014).

Global Innovation Cloud

Hjalager (2006) cautions that while globalization is progressing in scale and scope, the practical outcomes are unevenly distributed across enterprises, countries, and regions. For smaller destinations characterized by islands of the Caribbean even attempts to delineate localized regional or national innovation systems are problematic, since the innovation-base of tourism is so distributed across chains, international organizations, and expatriates, visitors, and returning and domiciled nationals. This caution applies also to the present model with the rider that her stages of globalization are to be distinguished from the historical phases of globalization that have led to the diasporas and cultures upon which tourism draws (see e.g. Pearce,1989; Chambers, 2007). This is certainly true of the case study above (see Cole and Razak, 2009 and 2012). The tension between local and overseas content and expectations of the industry (ownership, management, immigration, revenues) poses a central dilemma of destination management, addressed in the sustainable and alternative tourism literatures.

In the cluster model, assumptions as to an abundant global demand and investment are complemented by that of a "global innovation cloud." The reaches well-beyond the Caribbean, but has attributes linked to the location, vintage, and markets of the region's tourism. A destination's ability to absorb and translate global and regional know-how depends on skills, experience, and organization. Destination "innovation" includes the transfer and adapting of

technologies to local conditions, as well as local products adapted to visitor markets. Local "unique" cultures comprise a layered innovation heritage from previous eras of globalization - centuries of migration and adaptation to local resources. Exploiting this depends on an understanding of visitor markets and residents' aspirations, and concerns.

Figure 3 The Global Tourism Innovation Cloud

At the destination level, given the high degree of globalization of tourism as an industry, the relative smallness of destinations compared to the world scale or even the major tourism corporations, the majority of innovations are introduced from outside. With larger enterprises these come via international management, corporate policy choices, and in other peripheral ways via visitors, expatriate entrepreneurs, immigrants, and locals travelling and living abroad, transferring activities from other places with similar climate, geography, or history. The same diffusion happens in reverse with the smaller number of local innovations by hotel managers, restaurant and tour operators, and others diffusing overseas. Collectively, this upward diffusion from many destinations and corporations provides a "global innovation cloud" that businesses and destinations draw upon. In the simulation model, these innovation flows are superimposed onto the cluster model. Table 1 elaborates the 1-5 components shown in Figure 3, to be formalized further below.

Table 1. Elements of Destination Aggregate Technology and Innovation

Tourism innovations may be significant or marginal and adopted substantively or partially, but in aggregate they constitute the *quantifiable* destination-level innovation. Together, globalized demand and investment, localized clustering, innovation and policy can lead to a wide variety of dynamic trajectories.

Model Equations

This section summarizes the model equations given in Cole (Cole, 2007, 2011, 2012).

Demand-side:

The intrinsic attractiveness of destination-specific variables: attractiveness *a(t)*, marketing-effectiveness, *m,* and visitor market-segment demand *v,* including accessibility, all of which are variables related to the attributes and management of individual destinations. The combination *mva(t)* measures visitors' "preparedness-to-pay" based on their prior perception of the destination. This is modified over time. The overall attractiveness also varies as the number of available rooms in the destination cluster, *N* changes. Thus, overall transient attractiveness, and in turn expenditures per available room, is a combination of the intrinsic attractiveness, $B=B(t)$, the requisite variety or synergistic agglomeration stylized as $(1+ N(t)/A)$, and the crowding or carrying capacity, $(1-N(t)/C)$. These account for distance-related expressions such as crowding at the destination or internal accessibility of attractions). For the estimation below, the synergy and congestion terms are uniform across islands, but vary of over time.

$$v(t) = B(t)(1 + N(t)/A)(1 - N(t)/C) \qquad (1)$$

The importance of the synergy term for revenues is illustrated by Figure 4 which shows how the synergy and congestion process combine to give an inverted U-shaped curve. The curve intercepts the horizontal axis at *-A* and *C*. and has a maximum at *N= (A+C)/2* indicating that attractiveness and hence revenues per room, profitability, and growth rates will increase in the period following take-off. Different market segments and competing destinations have different parameters, so the intersection between their overlapping U-curves provides the criteria for tourist switching between them.

Figure 4 Cluster Synergy, Congestion, and Innovation

Supply-side:

A key assumption on the supply-side is that global investors base their decision to finance new properties primarily on perceived destination-wide performance, expected profitability, risk, and market size. In practice these are based on current occupancy rates and forecast visitors, translated into the number of new rooms to be developed. Investment is forthcoming provided the expected rate of return satisfies some hurdle, such as short payback horizon. Given this, the investment potentially available *K(t)* is the product of total rooms at the resort, *N(t)*, average annual surplus per room, *p(t)*, and the maximum number of years to recoup investment, the discount horizon for global capital is *y*.

$$K(t) = \alpha N(t)p(t)y \qquad (2)$$

The parameter *α* accounts for leveraging of more patient capital from secondary sources: the perceived-investment-opportunity "clearing" assumption for abundant footloose capital is that *α=1*. Profitability is the average destination-wide margin, sales *S(t)* minus costs per room,

$$p(t) = S(t) - e. \qquad (3)$$

The cost per room, *e*, includes all operating costs including local wages, taxes, and other expenditures, and overseas payments such as franchise fees and management. If labor is abundant locally, or through migration, then wages remain relatively unchanged. If profitability turns negative, then disinvestment occurs, and the number of rooms declines.

If a destination's style of tourism incorporates only accommodations with *h* rooms, then the number of new rooms *n(t)* to be developed or closed given the anticipated revenue stream is

$$n(t)=\{N(t)p(t)\alpha y/k\}_h \qquad (4)$$

Here *k* is the total investment cost required per room. The subscript indicates that the number of rooms at a destination steps up or down only in multiples of *h*. The size of *h* has implications both for the initial take-off of a destination and its and volatility in maturity, as do time-lags. For the time-step simulation, a key ingredient is the duration between the signal

triggering a decision and the implementation and operation of that decision. For new hotel construction, this lag-period may be several years.

Time-Step Simulation:.

From Equation 3, the period-to-period trajectory for the number of hotel rooms at the destination is

$$N(t+1,h)=N(t)+\{N(t)p(t)\,\alpha y/k\}_h \qquad (5)$$

Equations *(5)* and *(6)* are combined to give the computed growth equation:

$$N(t+1)=N(t)+\{(N(t)\alpha y/k)(maB(1+N(t)/A)(1-N(t)/C)-e)\}_h \qquad (6)$$

In contrast to the TALC model, Equation (6) includes synergy from clustering, which may raise the growth potential to levels that generate cyclical, even chaotic trajectories, exacerbated or stalled by lumpy investment, and multi-year time lags.

Technical Change:

The "global cloud" assumption implies systemic innovations (as opposed to discrete innovations) are transmitted across the industry. For purposes of estimation, below, these are treated as exogenous uniform time-varying changes. For example,

Intrinsic Attractiveness, $B(t+1) = B(t)(1+\beta);$

Synergy, $A(t+1) = A(t)(1+\delta);$

Congestion, $C(t+1) = C(t)(1+\gamma).$ (7)

The historic technological changes to *β, δ,* and *γ* are estimated from trends in the *B, A,* and *C* parameters across all destinations. They represent region-wide aggregate scale-related innovation in Caribbean tourism.

Parameter Estimation

The section summarizes an estimation of tourism innovation at the destination-level. As explained earlier, Equation 6 is an extension of the TALC model, which in turn is a variant the Lorentz model. Given the generally tumultuous global background for destination tourism, these relationships refute that there is a long-run equilibrium relationship between tourism development overall and economic growth. Tourism development in a small territory is intrinsically volatile, and subject to regular disruptions, making estimation of the non-linear dynamic equations somewhat challenging. Whereas most research on chaos models deals with the mature stage after the iteration has "settled down", here we are equally concerned with all stages of take-off,

development, and maturity, and the accompanying evolution of tourism technologies. This is illustrated by the two empirical examples for the island of Aruba in the next section.

Opportunities for region-wide parameter estimation are ultimately limited by sample sizes and the consistency of data and definitions across time and destinations (Cole, 2009a, 2012). The Caribbean, as a regional entity has sufficient variety to provide a plausible estimation of the key parameters of the model froom data on accommodation by destination, and estimates of capital costs, depreciation, construction lags, and island geographic data. Model validation is via a "two-step" process (cross-section, then longitudinal). The parameters established for the take-off and growth stages of development lead to empirically credible trajectories in the more mature stage, and are consistent with data on revenues, capital expenditures, and operating costs. The inverted U-curve shown in Figure 4 describing the relationship between size of a destination and its attractiveness to visitors is estimated using cross-section data for Caribbean and other islands.

The parameters used for capital costs and development lags are based on the empirical literature, and statistics for visitor arrivals and spending are from regional organizations (CTO, ECLA, UNWTO), supplemented by other sources. The growth potential μ depends on $\alpha y/k$, *mav, A/C,* and *b*. We set $\alpha = 1$ assuming that all perceived investment opportunities are taken, $y = 3$ reflecting an expected return of around 30% annually, the output/capital ratio, $k = 3$ based on the "1:1000 rule" that hoteliers should charge $1 nightly room rate for each $1000 cost of construction per room (Rohlfs, 2003; Smith, 2006, PKF, 2007). The time step, *T*, the typical time to implement a decision to develop a new property, is 2-years (Koeva, 2000; Maoz, 2008). Since the investment horizon and output/capital ratio are both halved key ratio *y/k* is independent of the time-step. On the demand-side, based on the estimations in Cole (2009a, 2012) the ratio *A/C* of requisite variety (synergistic agglomeration) to crowding (capacity) is set at 15-20% noting that the peak to intercept, given by $(1+C/A)(1+A/C)/4$, is sensitive to this ratio. Based on Caribbean-wide averages, the initial occupancy rate *mav* =60% and costs of operations are *50%* respectively of the pre-agglomeration full-occupancy annual income. The estimation of *B(t), A(t),* and *C(t)* and their annual rates of change β, δ, and γ for 20 destinations in the Caribbean illustrated in Figure 5 are made using ECLAC and CTO data from 1987 and 2001

Figure 5 A Cross-Island Estimation for Caribbean Destinations

Figure 5 shows the reported and model-predicted spending per visitor for each island and year. If the recorded spending is typically above the prediction, this suggests that the intrinsic attraction of the destination) are above average), and vice versa, and so may be used to further dissect the contributions of access and intrinsic attractiveness. Alternatively, as illustrated below, the parameter *B* for a given destination (measured against a base year) and the estimated synergy and congestion parameters used to explore past and potential trajectories for that destination. The estimated magnitudes of the three growth parameters suggest that on average, across the Caribbean, value competition nearly negates positioning and congestion innovation: in effect, the

intense global and regional competition, empirical evidence of Baumol's "innovation arms race" cited by Hall and Williams (2008).

Model Trajectories

The importance of the parameters to model trajectories changes over the projected life-cycle. During the take-off phase of a tourist destination, lumpiness in the accommodation stock conditions the required seeding and take-off conditions for the destination (Cole, 2007). Minimally, the net expected return after subsidies and time to reach target occupancy must be sufficient to attract investors. This implies that emergent resorts with large accommodations (small *N*, large *h*) generally require public subsidies until this threshold is met. In this initial stage, the model is sensitive to small changes in parameters that might determine the success or failure of the destination. Once take-off has begun, the attractiveness of the destination is greatly enhanced through clustering of other accommodations, sufficient to generate the variety desired by visitors. With this, the pace of development is accelerated. In less prosperous islands, with limited home-market, or poor issues, large resort-style projects from the outset incorporate the dining and other facilities needed to enhance synergies.

The synergy-congestion relationship assumes that dining and other facilities at a destination are approximately proportional-rata to the number of hotel rooms rather than the number of visitors, as in the TALC. With the TALC, the destination is perceived as increasingly over-crowded. With enterprises as the metric, this is replaced by that of excess choice. Once development reaches a level that visitors perceive there to be a sufficient range of accessible choice, the congestion component of the model begins to dominate the growth trajectory. At this stage, lags between the planning and operation promote excess room capacity so profitability slows and some businesses fail. Depending on precise circumstances (illustrated by variation in parameter values for characteristic accommodation, rates of return, and so on), this results in property closing, cyclical tendencies or other volatility.

Speculation about chaos in tourism systems arises mainly from their erratic performance during the mature stage. While the saturation and congestion at a destination may be delayed by various types of technical change – changing products, improving efficiency of land-use, and so on, this does not necessarily eliminate volatility or concerns about sustainability. To the extent that mistiming of investment is the underlying cause of volatility, Cole (200) provides a counter-cyclical adjustment rule to smooth the growth propensity below that expected to cause overshoot following an accelerated phase of development and remove fluctuations during the mature stage of development, and Cole and Razak (2004) proposed a slower pace of development for Aruba tied to longer-term domestic needs and population growth.

Empirical Application: Past and Projection for Aruba

Ideally we would test the equations against longitudinal time-series for multiple individual destinations. Unfortunately, there are rather few reliable life cycle long annual time-series data sets beyond total arrivals. Here, the estimated parameters based on data from the Caribbean-wide destinations, from regional and international agencies. These are used as a starting point for simulation of a comparatively data-rich destination, Aruba.

Records on arrivals and accommodation in Aruba have been assembled from the beginning of international tourism in the early 1950s (Cole and Razak, 2009). Visitor expenditure estimates are available only from 1972 onwards but definitions, sampling, and indexing vary considerably across sources, at least until the 1990s. The data from different sources (adjusted to consumer prices of their principal market) and the consolidated trend (averaged across all available sources for a given year) are shown in Figure 6. For projections and other model simulations, operating costs, including investment, wages, subsidies, and so on are adjusted exogenously as appropriate.

Figure 6 Backcasting and Forecasting Aruba

The volatility in occupancy seen in earlier years in Aruba arose from the relative large-scale accommodation that has always characterized the Island's style of tourism, and during the 1980s from an unfortunate concatenation of local and international events (Cole, 1986, 2007). Beyond the factors included explicitly in Equation (2), massive incentives (government-backed guarantees as the core of a recovery strategy following the closing of the Island's major oil refinery) propelled a nearly threefold increase in hotel accommodation between 1985 and 1993 leading to unopened properties and a suspension of new development. This involved a structural shift in the composition of accommodation toward timeshare from under 20% to over 50% While timeshare daily revenue per visitor is roughly half that of hotels, their occupancy is less affected by seasonal and other variabilities.

The model plausibly backcasts the observed early development, rapid growth overshoot, and a decade of disruptive fluctuations, at least until the early-2000s. It is apparent, however, from Figure 6 that the post-2004 projections of hotel and timeshare rooms using the model over-estimate the reported growth of accommodation in Aruba by about 1,700 rooms - approximately equivalent to 3-4 Aruba-style hotels. The explanation appears to be that, even though there has a slow-down on major hotel expansions, the increasing demand was taken up by new "alternative accommodation" (private homes, apartments, villas, condominiums), not included in the official accommodation statistics. The number of visitors using these "alternative" accommodations increased by 33% in 2015), comparable to growth in destinations in the US, EU, and elsewhere. Although the "rooms" are mainly in existing properties, the advent of on-line direct marketing via AirBnB, TripAdvisor, etc. has propelled expansion of this alternative. A web search of several online sites (adjusting for size, bookings, timeshare rental, internet growth rate, etc.) suggests that this is equivalent to about 1,500 rooms. This closes the "prediction gap." Internet marketing has

given old technology – B&B and private rentals - a new life, and is thus another step in aggregate island-wide innovation. This is illustrated in Figure 7.

Figure 7 Closing the Prediction Gap

The full implications of this innovation in tourist accommodation are unclear. Approximately half is close to the main tourist strip, in already-constructed homes, with the new visitors use established tourist amenities. This exacerbates present crowding on the primary beaches. This rapid growth, is relatively unfettered since, unlike the established style, it is not governed by investor returns, public planning approvals, and industry standards, that serves to moderate the pace of growth and balance development objectives. In response, to these less expensive offerings, some established hotels are shifting to more all-inclusive styles, reducing spending in the local economy and the prosperity that underpins a tourist-destination's livelihood. A pressing question therefore is whether these accommodations will exacerbate congestion, and reducing the appeal, of existing clusters, or whether they can be enticed through policy to nucleate new tourism clusters and offerings, and what are the trade-offs. The policy challenge for Aruba – and presumably for similar destinations - is that the extended consequence may be to undermine the existing tourism offerings and their sustainability.

Conclusions

The model described in this chapter has described a model of small destination tourism estimated using data for Caribbean islands, with empirical application for the past and near-term for the island of Aruba. It engages three geographic scales, global/regional, destination-level, and production unit, asserting that it is reasonable to treat these as clusters of like-activity with shared behavior. Arguably, such a synergy-congestion relationship is characteristic of most collective activities, and at all geographic scales. The amenity-based metric used in the model empahsizes that this relationship may be better viewed in terms of a destination's ability to provide an accessible and satisficing level of visitor choice rather than simply the consequences of overcrowding, as with the TALC. As shown here, our empirical estimation supports the notion of a cluster as the underlying structure of tourism in small island destinations and implies a long-run similarity in terms of aggregate innovation across these islands, despite their distinctive attributes. Deviations from average performance depend on other variables such as market segments, marketing, specific attractions and amenities, access, safety, service, products, inputs, and policy

Aggregate innovation is incorporated here only a steadily improving Caribbean-wide technical change to the three core parameters of the model describing intrinsic attractiveness, synergy and congestion. The argument for this is that with such a globalized industry and the presence of international enterprises in most destinations sharing competitive international markets, islands share similar information and concerns, and a common pool of innovations and technology. That

said, the timing of incentives for change to increase arrivals and spending, to promote new investment, and so on, depends greatly on local circumstances, as the example of Aruba clearly shows. A next step would be to adopt a vintage specification for technology with implementation at each destination linked, to the pace and scale of investment.

While there is empirical variability across destinations and over time, matching model trajectories to the observed trends has narrowed the range for parameter combinations for the clustering and associated technology change across the Caribbean. Further, the example of alternative accommodation in Aruba suggests that, despite considerable differences in scale and operation from existing accommodation, they share the underlying growth parameters of the estimated model. That the assumption of a uniform return on all accommodation in Aruba is sufficient to reconcile projections with available data, again suggests that rates of return (net of risk premiums) are uniform across accommodations within islands.

To refine parameter estimation on the demand or supply-side and further dissect the contributions to synergy, congestion, access, intrinsic appeal, or other phenomena, it is necessary to account for the Caribbean-wide fluctuations in visitor markets and the local variations in individual destinations. This requires us to address outstanding anomalies and gaps in the available data, and to disaggregate the data for multi-centered destinations, and their differential access to markets.

Beyond structure and estimation, the model provides a framework for exploring phenomena linked to tourism chaos and complexity. For example, individual shocks, cyclical, and stochastic events may be introduced. When the system is near a critical point, a small disruption can have significant short and longer-term outcome. The also model suggests rules for switching between competing products and destinations. At the regional and global levels the size and variety of markets, untapped destinations, chains and investors is ultimately constrained and discrete. Just as discrete and poorly-timed developments can disrupt growth at the destination-level, the emergence of new destinations and products and overall worldwide constraints on markets may be disruptive at the global level. Whether, ultimately, modeling at a more detailed description might best proceed by modeling upwards from discrete to collective properties, or downwards from the aggregate to the discrete, or both, remains an outstanding question.

References

Batty, M. (2005). Cities and Complexity. Cambridge: MIT Press.
Buhalis, D. (2000). Marketing the competitive destination of the future. Tourism Management 21 (2000).
Butler, R. (1980). The concept of the tourist area life-cycle of evolution: implications for management of resources. Canadian Geographer 24 (1), 5-12
Butler, R. (2009) Tourism in the Future: Cycles, Waves or Wheels? Futures. 41. May.

Capello, R., and P. Nijkamp. (2011). Regional growth and development revisited. In R. Stimson, R. Stough, & P. Nijkamp (Eds.), Endogenous Regional Development, Perspectives, Measurement and Empirical Investigation (pp. 301-324). Edward Elgar Publishing Limited.
Carlsen J., J. Liburd, D. Edward, and P. Forde. (2008) Innovation for Sustainable Tourism: International Case Studies. Curtin Business School, Curtin University, Western Australia
Carlsen, J. and R. Butler. (2011). Island Tourism: Sustainable Perspectives Edited by CAB International (www.cabi.org) 2011
César C. and V. Monfort-Mir. (2012). Measuring innovation in tourism from the Schumpeterian and the dynamic-capabilities perspectives. Tourism Management 33 (2012)
Chambers, E. (2007). Tourism on the frontier of culture and place. Futures. 41, 6, 335-426.
Clark, N. (1985). The Political Economy of Science and Technology, Basil Blackwell, Oxford.), p. 190 20
Cole, S. (2007). "Beyond the Resort Life Cycle: The Micro-Dynamics of Destination Tourism," Journal of Regional Analysis and Policy. 37(3):254-265.
Cole, S. (2010) “The Regional Portfolio of Disruptions, Protection, and Disasters”. Annals of Regional Science. 44 2 April 251-272.
Cole, S. (2011). "A Logistic Tourism Model: Resort Cycles, Globalization, and Chaos," Annals of Tourism Research 36:4, 689-714, 2009.
Cole, S. (2012a). “Synergy and Congestion in the Tourist Destination Life-Cycle”. Tourism Management. Volume 33, Issue 5, October 2012, Pages 1128–1140
Cole, S. (2012b). “Managing Chaos in Nonlinear Economic Systems: Globalization and Destination Tourism” in "Chaos and Complexity Theory for Business Management: Nonlinear Dynamics" (ed. S. Banerjee) ISI Global.
Cole,S. (2018). Concatenated Shocks with Resilience. in. Okuyama, Y. and A. Rose, Modeling Spatial and Economic Impacts of Disasters. Springer.
Cole. S. and V. Razak. (2009). "How Far, and How Fast? Population, Culture, and Carrying Capacity in Aruba," Futures Journal of Policy, Planning, and Futures Studies 41:6, 414-425, 2009.
Cole, S. and V. Razak. (2012). “Island Awash–Sustainability and Social Complexity in the Caribbean”, in Quality of-Life Community Indicators for Recreation and Tourism Management. (ed. R. Phillips) Springer
Cole, S. an Razak. V. (2015). Relocating CBP Border Inspections: The Potential Impact on Tourism in the USVI. National Center for Risk and Economic Analysis of Terrorism Events (CREATE). University of Southern California
Decelle, X. (2004) A Conceptual and Dynamic Approach to Innovation in Tourism. OECD, 2004
Erickson, S. and R. Pikul. (1976). Backcasting Global Models: A Resolution of the Controversy. IEEE Transactions on Systems, Man, and Cybernetics. September, p 648.
Freeman. C. and L. Soete. (1987). Technical Change and Full Employment. Basil Blackwell, Oxford
Hall and Williams (2008). Tourism and Innovation. Routledge. New York.
Hjalager, M. (1997). Innovation patterns in sustainable tourism: An analytical typology. Tourism Management, Vol. 18, No. 1, pp. 35-41, 1997
Hjalager, M. (2006) Stages in the Economic Globalization of Tourism. Annals of Tourism Research, Vol. 34, No. 2, pp. 437–457, 2007

Hjjalager, M. (2010). A review of innovation research in tourism. Tourism Management 31 (2010) 1–12
IMF (2014) Revisiting Tourism Flows to the Caribbean.
https://www.imf.org/external/pubs/ft/wp/2014/wp14229.pdf

Keller, P. (2004). Conclusions of the Conference on Innovation and Growth in Tourism. OECD. Paris. Kim, N. and B. Wicks. (2010). "Rethinking Tourism Cluster Development Models for Global Competitiveness" http://scholarworks.umass.edu/refereed/CHRIE_2010/Friday/28(July 30, 2010). International CHRIE Conference.
Krugman, P. (1991 Increasing Returns and Economic Geography. Princeton.
Lorentz, E. (1963) Deterministic Non-Periodic Flow. Journal of Atmospheric Science 20:130–141.
Lundtorp, S., and S. Wanhill (2001). The Resort Life Cycle Theory: Generating Processes and Estimation. Annals of Tourism Research 28:947–964.
McKercher, B. (2018) The impact of distance on tourism: a tourism geography law, Tourism Geographies, DOI: 10.1080/14616688.2018.1434813Murphy K. et al. (2000). An Exploratory Study of Global Issues Impacting the Future of Tourism in Aruba. Rosen College of Hospitality Management. Florida.
Namhyun, K. and B. Wicks. (2010). "Rethinking Tourism Cluster Development Models for Global Competitiveness" (July 30, 2010). International CHRIE Conference
Nedergaard (2013
Nordin, S. (2003). Tourism clustering and innovation: Paths to economic growth and development. Oestersund, Sweden: European Tourism Research Institute, Mid-Sweden University.
Orfila-Sintes, F. and J. Mattsson,(2009). Innovation Behavior in the Hotel Industry. Omega 37(2):380-394
Ozturk, H. (2009). The role of cluster types and firm size in designing the level of network relations: The experience of the Antalya tourism region. Tourism Management 30: 589–597
Miles, I. (2016), "Twenty Years of Service Innovation Research" in Toivonen, M. (ed) Service Innovation: Novel Ways of Creating Value in Actor Systems, (Translational Systems Sciences, Vol. 6) Springer.
Nedergaard, N. and R. Gyrd-Jones. (2013). Sustainable brand-based innovation: The role of corporate brands in driving sustainable innovation. October 2013Journal of Brand Management 20(9). DOI10.1057/bm.2013.16
Patuelli, P, M. Mussoni, G. Candela. (2014). Cultural offer and distance in a spatial interaction model for tourism. Economics and Business Letters 3(2), 96-108, 2014
Pearce, D. (1989). Tourist development. Author, Douglas G.. Edition, 2, Publisher, Longman.
Plaza, B., C. Galvez-Galvez, and A. Gonzalez-Flores. (2011). Orchestrating innovation networks in e-tourism: A case study. African Journal of Business Management Vol. 5(2), pp. 464-480.
Poon, A. (1988) Innovation and the future of Caribbean tourism. Tourism Management, 1988 – Elsevier.
Porter, M.E. (1990) The competitive advantage of nations. New York. Free Press. Florida

Pratt, A. and P. Jeffcutt. (2010). Creativity, Innovation and the Cultural Economy: Snake oil for the 21st Century? Routledge. London
Russel, R. and Faulkner, B. (1999) Movers and Shakers: chaos makers in tourism. development, Tourism Management, Vol. 20, No 4: 411-423.
Shoval, N. B. McKercher, E. Ng. and A. Birenboim (2011). Hotel Location and Tourist Activities in Cities. Annals of Tourism Research, Vol. 38, No. 4, pp. 1594–1612, 2011
Sterman, J. 2015. Booms, Busts, and Beer: Understanding the Dynamics of Supply Chains. Handbook of Behavioral Operations Management in E. Bendoly, van Wezel, W., Bachrach, D., eds. New York, Oxford University Press: 203-237.
Utterback, J. and W. Abernathy. (1975). A Dynamic Model of Product and Process Innovation. OMEGA, The Int. JI of Mgrnt Sci., Vol. 3, No.6, 1975. Pergamon Press. Printed in Great Britain
Van der Vorst, J. 2004 Supply-chain Management: Theory and Practices. T. Camps, P. Diederen, G. Hofstede, B. Vos (eds) (2004), The Emerging World of Chains & Networks, Elsevier.
Vernon, R. 1966. International Investment and International Trade in the Product Cycle. Quarterly Journal of Economics, Vol. 80, pp. 190-207.
Weidenfeld, A., M Williams, and R Butler (2010), 'Knowledge transfers and innovations amongst attractions'. Annals of Tourism Research 37(3): 604-626
Yin, L., S. Cole, and Wu, L. (2014). Exploring the Dynamic Spatial Patterns of Hotel and Entertainment Development: Savannah, Charleston, and New Orleans from 1997 to 2011. ACSP Annual Conference. Philadelphia, PA,

Table 1. Elements of Destination Aggregate Technology and Innovation	**Model Specification**
1. Global Innovation Cloud Product and Process Innovation and Diffusion from many destinations and sectors Destination selection by visitors and Investors based on experience, marketing, etc. Distance from markets and other accessibility variables are subsumed into the intrinsic attraction parameter.	*B(t) with ∂B/∂t<0*
2. Synergy and Choice Enhancing Product Innovation Emphasizes Product Quality, Variety, Novelty, Creative Adaptation, Commodification of Heritage, Colocation and Customization within Geographic and Thematic Clusters	*A(t) with ∂A/∂t<0*
3. Congestion and Cost Reducing Process Innovation Emphasizes Process through Up-scaling, Design, Refinement, Delivery, Management, Marketing, Transportation, and Incorporating Products, Plannedand Unintended within Geographic and Thematic Clusters	*C(t) with ∂C/∂t>0*
4. Destination-Specific Heritage Natural and Cultural Attractions Embedded Technology, Crafts, Customs, and Organization. Innovated, adapted, and accumulated technologies drawn from successive layers of native, immigrant, and industrial heritage during previous phases of globalization (4a). Potential source of new products but also depleted and transformed over time.	*B(0), A(0), C(0)*
5. Discrete Planning & Policy Innovation New styles of Accommodation and Attractions, Visitor Safety, Arrivals, Quality Control, Collective Events such as Festivals, Destination Marketing, and Planned Repositioning	Adjustments to *A, E, B, C* and other technology parameters (see text)

Figure 1. Aruba Markets and Arrivals versus Flight Time.

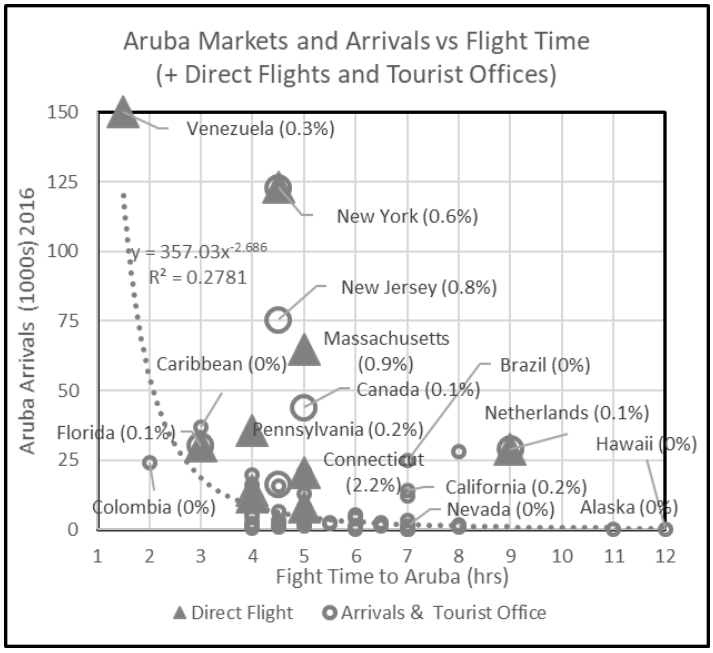


Figure 2 The Global-Local Destination Model.

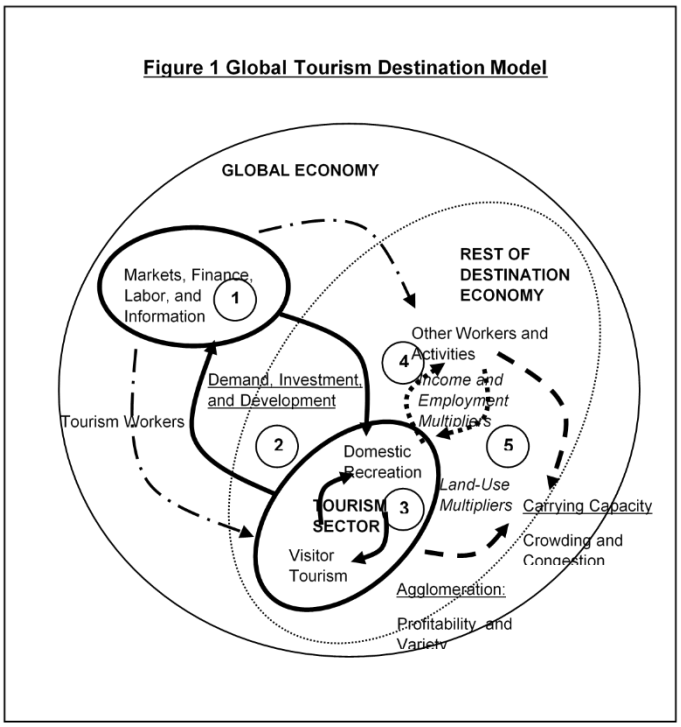


Figure 3 The Global Tourism Innovation Cloud

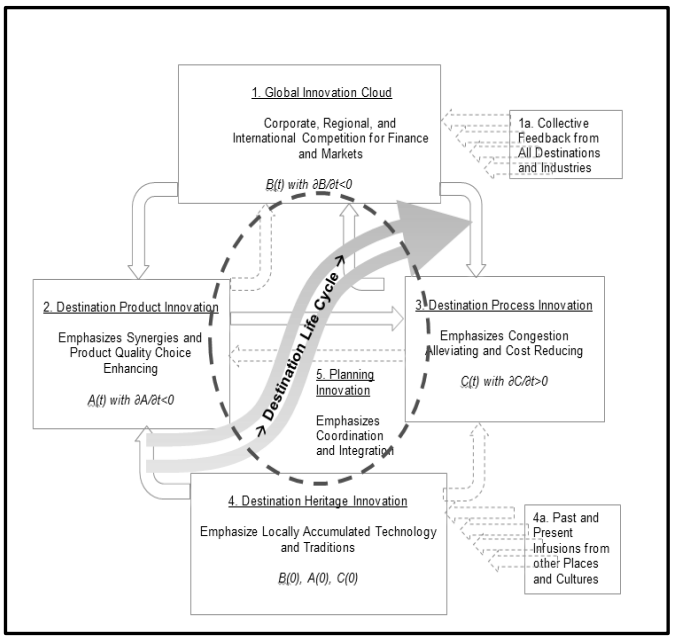


Figure 4 Cluster Synergy, Congestion, and Innovation

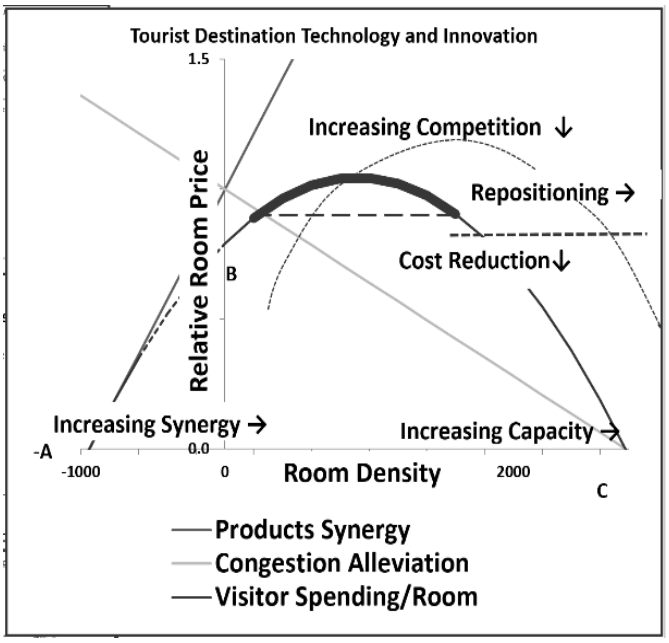


Figure 5 A Cross-Island Estimation for Caribbean Destinations

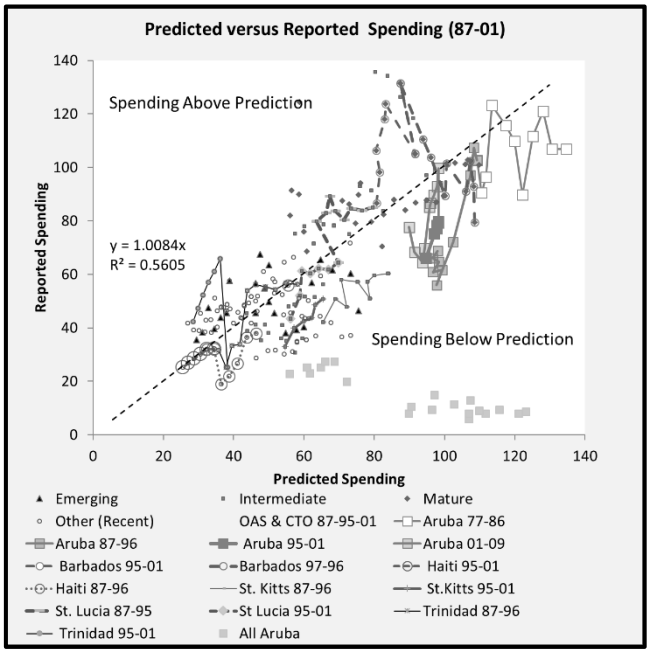


Figure 6 Backcasting and Forecasting Aruba

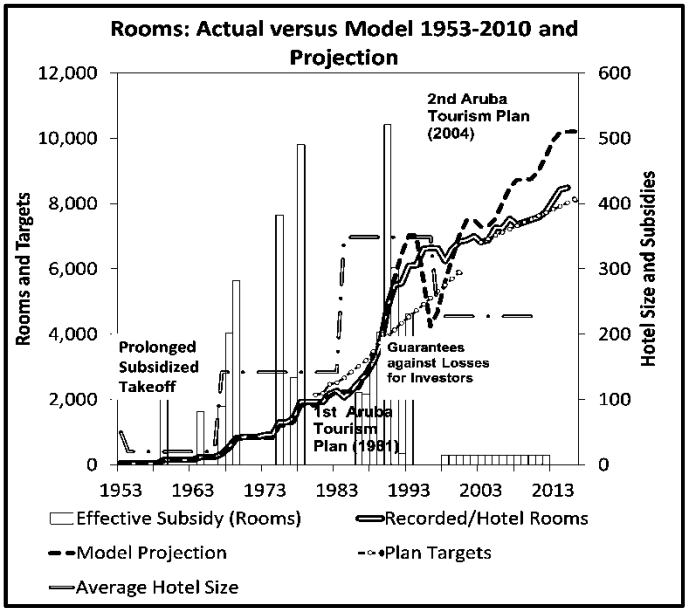
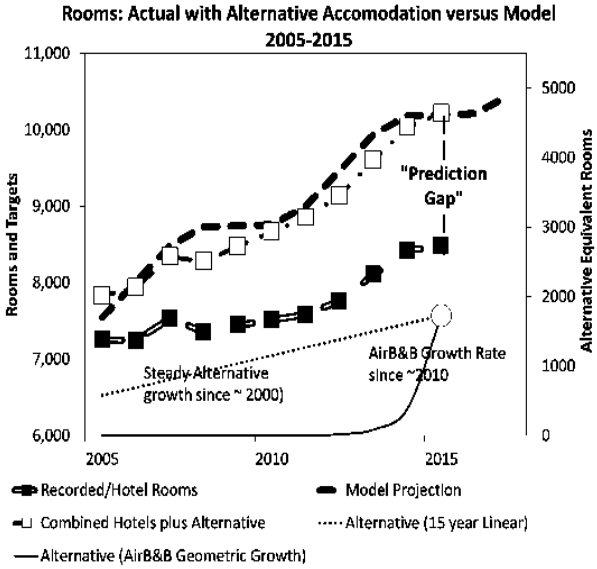


Figure 7 Closing the Prediction Gap



	Nov 2015	Nov 2016	Change %
Hotels (37)	38	37	-3%
B&B and Inns (30)	27	30	11%
Specialty Lodging (83)	70	83	19%
Vacation Rentals (709)	651	709	9%
Source: TripAdvisor			